

FY-2001 PROGRAM DIRECTIVE

WILLIAM J. HUGHES FAA TECHNICAL CENTER

NAS System Engineering and Analysis Division
NAS HUMAN FACTORS BRANCH, ACT-530

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FY-01 Program Directive
Air Traffic/Airway Facilities Human Factors Concept Research
NAS Human Factors Branch (ACT-530)

1. Overview

This document describes a research program to be conducted by the NAS Human Factors Branch, ACT-530, under the sponsorship of the Office of the Chief Scientist for Human Factors, AAR-100, during fiscal year FY-2001. ACT-530 conducts human factors research and works primarily in Federal Aviation Administration (FAA) air traffic control and airway facilities domains. The work covered under this specific program directive involves air traffic controller and airway facilities human factors research derived from advanced concepts as established in the FAA's Concept 2005 document and NAS version 4 as well as from guidance received from AAR-100.

The air traffic forecast indicates that the air traffic will continue to increase and is expected to double in the next twenty years. Meanwhile, the operating and maintenance systems of the National Airspace System (NAS) are aging. New systems and concepts are essential. Therefore, the FAA is modernizing the automation systems that will be used by air traffic controllers and maintenance technicians.

Modernization success will involve new approaches to resolving human factors issues. ATS and other FAA management and employee organizations have made great strides toward ensuring that users of the equipment must be actively involved in the development of new systems. System developers must consider the human factors issues early in the system design process. Doing so reduces potential costs and minimizes program schedule disruptions. During the past year there has been renewed interest in longer-term forward-looking research.

The capabilities and limitations of personnel are important in current and potential future NAS configurations. This research is a necessary component of the overall system development program. There is the potential for human factors issues within each potential change and with the transition from the current system to new systems and concepts.

The system will not improve simply by implementing change because technology makes it possible. Developers must grasp the impact of potential change. In order to make informed decisions, designers and systems procurement personnel need data and feedback concerning what change really means for the operators and the system.

The NAS is a system in evolutionary transition. Many systems concepts are on the drawing board. Human factors should be an integrated part of every system slated for change or improvement. There are insufficient resources to effectively address all potential questions at once. We must tailor a human factors program in such a way to acquire data and additional understanding of the operator in the loop on a priority basis. This is one piece of a larger picture, which must evolve over time. The FY-01 program

and tasks are part of a multiyear, multi-organization, and multi-method approach. The grand scheme of the overall effort will be created by the cooperative integration of the research efforts of the William J. Hughes Technical Center, other FAA and DOT organizations, as well as supporting contractor and university research, if and where applicable.

ACT-530 will take principal responsibility for the planning, conduct, data collection, analysis, and interpretation in the research domains described in this document. AAR-100 will participate in the planning process of the research and review the final products. In order to accomplish this a sequence of tasks will occur.

2. General Tasks - Shall include but not necessarily be limited to the following:

- Problem definition in consultation with sponsors and background research (ACT-530/AAR-100)
- Operational definitions of all necessary terms and concepts (ACT-530/AAR-100)
- Participating as full partners in the test planning process (ACT-530/AAR-100)
- Identification of measures and methods (ACT-530)
- Planning and coordinating each of the research efforts (ACT-530)
- Ensuring clearance by the institutional review board for the ethical treatment of human participants (ACT-530)
- Recruiting participants as required (ACT-530)
- Setting up all equipment and software needed (ACT-530/ACT-510)
- Arranging all necessary personnel to include research paraprofessionals and simulation pilots where required (ACT-530)
- Scheduling resources (ACT-530)
- Conducting simulations where appropriate (ACT-530)
- Planning and conducting a limited sample of surveys where applicable (ACT-530)
- Developing and evaluating prototypes as required (ACT-530)
- Conducting usability studies when needed (ACT-530)
- Developing and/or improving measurement tools as required (ACT-530)
- Collecting all required data (ACT-530)
- Conducting analyses as required (ACT-530)
- Writing reports or white papers in each respective domain (ACT-530)
- Providing timely, constructive reviews of reports (AAR-100)
- Providing lessons learned and human factors recommendations (ACT-530)
- Recommending appropriate follow-on research efforts (ACT-530/AAR-100)
- Complete draft test plan not less than two months prior to data collection (ACT-530/AAR-100)
- Provide monthly progress summaries on projects covered in this Program directive (ACT-530)

Task areas will be conducted in parallel where possible. Schedules are written in terms of months rather than specific dates. They assume a base month beginning with the signing of the program directive document and subsequent funding. They also assume some carryover of research obligations from FY-2000 due to schedule delays brought about by resource limitations, primarily simulation facilities and participant availability.

3. Outputs

- Technical notes, white papers, and oral briefings as appropriate to meet the sponsors' and/or customers' needs.
- Wherever practicable, refinements to ground side performance metrics, research methodology, and knowledge for assessments of future air-ground integration studies.

4. Schedule

Each study will have its own schedule as indicated in the project summaries below.

5. Relationship to other plans and ARA Goal 2

The activities outlined in this plan were derived from the context of other strategic plans within the FAA. These strategic plans identify a number of key areas where addressing human factors issues would be valuable to Air Traffic and Airway Facilities. ARA performance Goal 2 focuses on the role of human factors in aviation safety. It states the following objectives: By 2005, ensure human factors policies, processes, and best practices are integrated in the research and acquisition of 100 percent of FAA aviation systems and applications. Progress toward this performance goal will be measured by the percentage of systems and applications that satisfy human factors policies, processes, and best practices. The strategies ARA will pursue to accomplish this goal include: a) conduct human factors research to provide the knowledge base and foundation for the integration of human factors into acquisition of FAA systems and applications and b) apply human factors policies, processes, and best practice through engineering activities and assessments to ensure human factors are integrated in FAA acquisitions and applications.

The program described in this directive is dedicated to supporting ARA Goal 2. ACT-530 shall keep AAR-100 informed on a recurring basis concerning progress of all projects described below.

Project Descriptions, Schedules, and Cost Estimates

Program Area: Airway Facilities

Project Name: Human Factors Design Guide CD-ROM

Project Description: Human Factors Design Guide CD ROM

The design and development of FAA aviation systems relies on the integration of human factors principles, methods, and best practices. The existing version of the HFDG was developed in 1996 to overcome the limitations of military design guides and standards and to provide a consolidated human factors reference source. In the last four years, new information related to advances in research and technology has become available, necessitating revisions to some sections of the document. Over the last two years, two key chapters of the HFDG have been updated and revised. The challenge now is to make the new information available to the people who need it.

Relationship to NAS and Agency Goals and Objectives: The National Plan for Civil Aviation Human Factors, Information Management and Display, Appendix A Requirement Area 1, 2, 3, & 6.

Relationship to Previous and Future Research: ACT-530 has recently revised Chapter 8 on computer-human interface, and is in the process of revising Chapter 5 on automation.

Schedule: Human Factors Design Guide CD-ROM

Task to be completed	Time in Months
Write new introductory material	2
Review and revise material	3
Update table of contents, index and references	5
Create new electronic interface for document	8
Update multimedia content of document	10
Burn prototype CD, Test on different computer platforms, and burn final copies	12

Cost Estimate: Human Factors Design Guide CD-ROM

Cost Source	Cost
Contract support	
Computer/technical support	
CD ROM production	
Distribution	
Subtotal	

Potential User:

Human factors professionals, acquisitions programs

Program Area: Airway Facilities

Project Name: Communication and Coordination within Airway Facilities

Project Description: A key concept to the future of Airway Facilities (AF) within the National Infrastructure Management philosophy is an environment characterized by partnerships involving intense collaboration and coordination among users, customer, providers and stakeholders. There are several human factors implications of increased collaboration and coordination in the AF environment. Human factors specialists need to baseline the current communication and coordination processes and identify any areas of weakness in the current methods of communication and coordination. As AF moves toward the implementation of OCCs, human factors specialists need to identify the impact of modernization on the communication and coordination processes on performance, errors and workload.

Relationship to NAS and Agency Goals and Objectives: The National Plan for Civil Aviation Human Factors, Appendix A. requirement area 7 Operations in a NIM Environment says: “The (NIM) functions will be applied in an environment characterized by intense collaboration and coordination among users, customers, providers stakeholders and the NIM components.”

ATS Concept of Operations 2005 says: “Increased real-time collaborative communication among users and service providers will occur.” The concept of operations 2005, which describes the future infrastructure management system as involving close collaboration with infrastructure users to ensure the right service and priority, is applied to service delivery.

Relationship to Previous and Future Research: ACT-530 has already undertaken a study to examine coordination and collaboration between AF and the primary customer of AF, Air Traffic Control. Further research is needed to examine communication and coordination within AF.

Schedule: Communication and Coordination within Airway Facilities

Task to be Completed	Time in Months
Primary research design	2
Literature review	3
Research plan	4
IRB approval	5
Coordination of field visits	6
Field visits and data collection	8
Data analysis	10
Final report	12

Cost Estimate: Communication and Coordination within Airway Facilities

Cost Source	Cost
Contract support	
Travel	
Materials	
Subtotal	

Program Area: Airways Facilities

Project Name: Visual Symbolology in AF

Project Description: The variety of symbols on AF displays is increasing as the number of systems and applications grows in the FAA. Currently, a number of modernization efforts are underway, including free flight, NIMs and the Enhanced Communication Gateway (formerly part of Eunomia). Each of these efforts is independently developing symbology. Because of a lack of standardization, AF specialists may see different symbols used to represent the same thing or similar symbols used to represent different things. This can lead to an increased risk of errors in interpreting and responding to symbols. The need for symbology research will only increase as the NAS continues toward modernization, as both the number of new systems and new symbology will increase. This project will document current symbols, mitigating errors by identifying potentially error-prone symbology.

Relationship to NAS and Agency Goals and Objectives: A key reference is The National Plan for Civil Aviation Human Factors, Information Management and Display, Appendix A Requirement Area 6 & 7. NAS Architecture 4.0 for en route operations and services poses several research requirements and issues. One of these issues is to conduct an en route analysis in support of the design and development of a new and integrated ARTCC inventory of visual and auditory alerts and alarms.

Relationship to Previous and Future Research: The ACT-530 Human Factors lab has a long history of conducting symbology research. This research has resulted in several publications, including: *Visual and auditory symbols: A literature review* (1994), *Symbol development guidelines for airway facilities* (1997), and *Symbol standardization in airway facilities* (1998). The symbols used in the field have changed since the time of the past research, resulting in the need for new evaluations. This project benefits the maintenance technician by examining the symbology AF specialists are exposed to. This can result in reduced training requirements, easier transitions in facility transfers, and reduced interpretation errors.

Schedule: Visual Symbolology in AF

Task to be Completed	Time in Months
Write test plan	2
Develop survey tool with help of SME	4
Go through IRB	5
Coordinate field visits	5
Collect field data	8
Analyze field data	10
Write report	12

Cost Estimate: Visual Symbology in AF

Cost Source	Cost
Contract support	
SME	
Travel	
Subtotal	

Program Area: Air Traffic

Research Name: Decision Support Automation Research 2 (Deferred)

Project Description: A new operational position for enroute air traffic control has been discussed and developed in several government and industry laboratories over the past few years. The new position, a multisector planner, would serve as a strategic planner with functions similar to the traffic management unit. However, the new position would serve to strategically plan traffic management at the multisector level. Mitre CAASD, as well as Eurocontrol, and NASA Ames have proposed concepts related to this position. To date, however, the work on the position has been primarily conceptual, in which controllers provide comments about the functions of the position. The HFDRL can initiate a project to investigate several concepts of roles and responsibilities of this new position in the current operational environment. To investigate the effect of future decision support automation tools, this baseline must establish the current capabilities and limitations of ATCSs working without automation. *Key Research Questions:* Is this operational concept feasible in the automated ATC environment? (i.e., are safety and efficiency improved with the planning position and decision support tools?) Does one configuration of roles and responsibilities have greater benefits than others? Does the implementation of a planner decrease the workload, and/or situational awareness of the radar controller? What information does the planning position need and how should the information be presented to maximize the cognitive capabilities of the ATCS?

Relationship to NAS and Agency Goals and Objectives: National Plan for Civil Aviation Human Factors, Human Centered Automation and Human Performance and Assessment Thrusts; (including, keeping the operator-in-the-loop and situationally aware of system performance, balancing operator workload associated with automated systems; and identifying the intrinsic characteristics of individuals and teams that determine how well they are able to perform aviation tasks). ARA Performance Goal 2.1 – Human Factors. NAS Architecture Version 4. The project addresses Human Factors Transition issues, including roles and responsibilities. 2000 FAA National Aviation Research Plan, Chapter 8.

Relationship to Previous and Future Research: This study is part of multi-year series to support NAS transition and integration by understanding how decision support automation affects the way controllers accomplish their jobs. It is hypothesized that as new decision support tools are implemented, the controller will shift from the current tactical, sector based control of traffic to more strategic actions. The DSAR2 study, can formally investigate the addition of decision support tools to the multisector planning position. It will also provide the opportunity to examine the addition of multiple support tools (e.g. URET and/or Direct To) and the integration of the information provided by each. Future studies may address maximizing the integration of new tools through application of human factors principles for the complex cognitive environment of ATC.

Schedule: Decision Support Automation Research 2 (DSAR 2)

Task to be Completed	Time in Months
Primary research design	1
Literature review on decision aid tools and conflict probe approaches	2
Research Plan	3
Airspace definition and scenario development	4
DST development or Adaptation	6
IRB approval	6
Conduct simulation study	9
Conduct DR&A	10
Complete data analysis	11
Write documentation	12

Cost Estimate: Decision Support Automation Research 2 (DSAR 2)

Cost Source	Cost
Contract Support	
Simulation Pilot Support	
Detail controller	
Participant OT/Travel	
Materials/Equipment/Miscellaneous	
Total (<i>Deferred</i>)	

Program Area: Air Traffic

Project Name: Multisector Planner Workshop (Deferred)

Project Description: A new operational position for enroute air traffic control has been discussed and developed in several government and industry laboratories over the past few years. The new position, a multisector planner (MSP), would serve as a strategic planner with functions similar to the traffic management unit. The purpose of the MSP workshop is to provide an opportunity for each of the laboratories working on this concept, as well as operational managers (e.g. SUPCOM) to meet to exchange information, techniques, and tools for developing the strategic planning capability at the sector level within the air traffic system. The workshop will identify operational issues, research needs, and information and tools requirements to support such a position.

Key Questions: What is the current state-of-the-art in multisector planning positions?

Relationship to NAS and Agency Goals and Objectives: National Plan for Civil Aviation Human Factors, Information Management and Display Thrust to identify the most efficient and reliable ways to exchange information...transfer information between system components. ARA Performance Goal 2.1 – Human Factors. NAS Architecture Version 4. Project addresses Human Factors Transition issues. 2000 FAA National Aviation Research Plan, Chapter 8.

Relationship to Previous and Future Research: This workshop ensures the exchange of technical information from the decision support automation research program with international researchers and operational personnel with the variety of implementations of the multisector planning positions.

Schedule: Multisector Planner Workshop

Task to be Completed	Time in Months
Workshop Planning	2
Workshop Preparations	4
Conduct Workshop	6
Prepare Workshop Summary and Documentation	10

Cost Estimate: Multisector Planner Workshop

Cost Source	Cost
Contract Support	
Materials/Equipment/Miscellaneous	
Total (<i>Deferred</i>)	

Program Area: Air Traffic

Program Name: Supervisor Information Needs Assessment (Deferred)

Project Description: Much attention to human factors issues and design considerations associated with NAS transitions and integrations of new technology into today's operations has been given to the decision support tools required at the sector level by the ATCS. However, little to no information is available about the information requirements needed by the 1st level supervisor. The transition from the PVD environment to DSR in enroute centers has anecdotally already resulted in the loss of information (e.g. "quick look" capability in each area), which was formerly available to the supervisor in some cases. In addition, with the DSR supervisor's workstation, a variety of systems and their associated computer monitors have been placed at the supervisor's desk. To date, there has been no human factors or needs assessment of the information requirements of the supervisors.

This project can conduct an assessment of the information requirements at the supervisor's station, as well as an assessment of the current status of the workstation. The project will provide the basis for human factors guidelines for future modifications to the supervisor's workstation, as well as provide recommendations for development of tools for use by ATC supervisors.

Key Research Questions: What are the information needs of the 1st level supervisors? What is the optimal presentation of the information?

Relationship to NAS and Agency Goals and Objectives: National Plan for Civil Aviation Human Factors, Information Management and Display Thrust to identify the most efficient and reliable ways to exchange information...transfer information between system components. ARA Performance Goal 2.1 – Human Factors. NAS Architecture Version 4. Project addresses Human Factors Transition issues. 2000 FAA National Aviation Research Plan, Chapter 8.

Relationship to Previous and Future Research: This study can be the initial investigation of supervisor information requirements. The project was derived from a request by AAR-100 to examine the use of a supervisor's URET workstation as a multisector planning position. This examination revealed the need for a systematic review of the supervisors' information needs. The study integrates with the DSAR examination of decision support automation tools for ATCS and extends the research to include supervisory information needs. It is the first in a series of at least two to examine and recommend Human Factors Guidelines for supervisors.

Schedule: Supervisor Information Needs Assessment

Task to be Completed	Time in Months
Primary research design	1
Literature review on decision aid tools, supervisor information needs assessment, integrate NAS Architecture Version 4 HF	2
Research Plan allowing for AAR general review prior to IRB submission to accommodate changes	4
IRB approval	6
Conduct needs assessment data collection	8
Complete data analysis	10
Write documentation	12

Cost Estimate: Supervisor Information Needs Assessment

Cost Source	Cost
Contract Support	
Detail controller	
Travel	
Materials/Equipment/Miscellaneous	
Total (<i>deferred</i>)	